144

SCIENCE

A WEEKLY NEWSPAPER OF ALL THE A[illegible] AND SCIENCES.

PUBLISHED BY N. D. C. HODGES, 874 BROADWAY, NEW YO[illegible]

TENTH YEAR. Vol. XX. No. 494. | JULY 22, 1892. | S[illegible] COPIES, TEN CENTS. $3.50 [illegible], IN ADVANCE.

CONTENTS.

Entered at the Post-Office of New York, N.Y., as Second-Class Mail Matter.

SCIENCE

NEW YORK, JULY 22, 1892.

A VISIT TO A "PICT'S HOUSE."

BY DAVID MAC RITCHIE.

As I have to-day visited an admirable specimen of the underground structures so frequently found in Scotland, where they are popularly known as "Picts' Houses," some description of it will, I think, prove interesting to the readers of *Science*, although the place itself has long been known to antiquaries. There are very many examples of these structures in the British Isles, notably in Scotland and Ireland, but unfortunately the information regarding them (almost invariably most exact and detailed) is for the most part buried in the various volumes of "Transactions" of antiquarian societies, and is thereby practically useless. If the descriptions already published regarding these buildings, together with reproductions of the diagrams illustrating them, could be focussed into one volume, the result would be of the highest interest to those who have paid attention to the subject, and would be a positive revelation to those who have not yet done so.[1] And one great advantage to be derived from a comparison of the various delineations would be that the student would realize that, although such structures are referred to under many names (such as underground caves, souterrains, weems, cloghauns, Picts' Houses, and — popularly — fairy halls), they all belong to one great class.

The specimen visited by me to-day is situated at Pitcur, in Forfarshire, about two miles to the south-east of the small town of Coupar-Angus, and is locally known as "the Picts' house." It is entirely beneath the surface of the ground, and the portion of it which is still covered over stretches for about twenty feet beneath a ploughed field. That is to say, its roof is covered by a foot or two of soil, through which the plough passes without ever striking the flat, stone roof below. In other cases, indeed, the ploughshare has often been the first discoverer of these subterranean galleries.

The ground-plan of the Pict's House at Pitcur may be roughly described as of a horseshoe shape, with a shorter gallery parallel to the exterior curve of one side. The horseshoe itself is about 130 feet in length from end to end, with an average depth of 6 or 7 feet, and an average breadth of about 6 feet. The shorter gallery is about 55 feet long, and its dimensions otherwise resemble those of the horseshoe, except that it broadens out into a bulbshape at the inner end — a common feature in such structures. The line of length, in each case, is taken along the middle of the gallery, there being, of course, a great difference between the length of the inner and outer curves.

Be it understood that both of these galleries are, as it were, great symmetrical ditches or drains, quite underground, and entered by several burrow-like doorways. Their sides have been carefully-built walls of large, unhewn, unmortared stones, and these are still to a great extent unimpaired. The roof was formed by bringing the upper tiers of the wall slightly together, and then placing huge slabs of stone across from side to side. Two of the largest of these roof-slabs measure as follows: One (the largest of all) is about 74 inches in length, by 58 inches in breadth, and from 11 to 13 inches in thickness, its shape being an irregular oblong. The other is about 60 inches long, by 48 inches broad, and 12 inches thick. These are certainly very large specimens, but one is always struck by the great size of the flag-stones used in roofing these underground retreats. I have described as unhewn all the stones employed in this building, but (as in similar cases) one is led to conjecture that some rough process of shaping must have been adopted, although the outlines are perfectly rude, and no trace whatever is visible of any tool. The selection of these great stones, whether from a quarry or a hillside, their carriage to the scene of action (often from a very great distance), and the method used in placing them in position, are all problems which have greatly puzzled antiquaries.

In the Pitcur "house" most of the roof-slabs have disappeared, having obviously shared the fate of so many monuments of antiquity, at the hands of proprietors and farmers in need of building materials and quite devoid of all interest in archæology. But (perhaps because it goes underneath arable land) the northern portion of the great horseshoe gallery still retains its roof; and this part of the building is, therefore, in all probability, in its original condition. It appears to have been of itself a "house," apart from the main gallery of which it forms a portion, for it has a carefully-built doorway leading into the main gallery; and, moreover, an extra ascent to the upper earth leads from the side of the wall just at the outside of this doorway. On going through the doorway of this inner portion, one finds, on the right hand, a small recess in the wall, about 33 inches high, 23 inches broad at the floor, and going into the thickness of the wall about 21 inches. Although this cavity is 23 inches broad at the base, the two slabs which form the supports of its little doorway are made to slant towards the top, where the breadth narrows to 14 inches. Within this recess it is possible for a man of 5 feet 10, and of proportionate breadth, to sit in a squatting posture; but it is a very "tight fit." I am particular in giving the dimensions of this recess, because the late Captain Thomas, a naval officer who devoted much time and study to these subterranean structures, and who found this little recess on the right hand of many of their doorways, regarded them as probably identical with the "guard-cells" of the Pictish "brochs." Captain Thomas quite realized that if these were really "guard-cells" they were useless for any but men of distinctly small stature — an attribute of the Picts, according to tradition.

It is difficult to convey a true idea of such buildings by written description alone, but perhaps these notes will give the readers of *Science* some impression of an example of a very interesting class of structures.

Easter Logie, Perthshire, Scotland, July 1.

[1] I may mention that, as a small beginning in this direction, I am about to issue a pamphlet (published by David Douglas, Edinburgh) containing several written descriptions and sketches of such structures; extracted from the "Proceedings of the Society of Antiquaries of Scotland."

KEY TO THE MAYA HIEROGLYPHS.

BY CYRUS THOMAS, PH.D.

I GIVE here in as limited space as possible a list of the Maya letter 'glyphs so far as I have determined them, together with the corresponding phonetic equivalents; and some examples of my attempts at deciphering the written characters of the Codices.

It is necessary to explain that the letter-equivalent given to each is to be understood as only the chief phonetic element of the character represented, for, in most cases, more than this chief or prominent element is included in the one symbol. The consonant sounds are those chiefly represented, but the character, as a rule, combines therewith a vowel and sometimes even a subordinate consonant sound. Hence it happens that the same consonant sound is represented by several different characters depending upon the subordinate phonetic elements combined with it. A change, however, in the character does not necessarily follow from a change in the order of the phonetic elements it represents; thus, what denotes *ci* as a prefix may stand for *ic* or *c* at the end.

The examples given of the added vowel and subordinate consonant elements, are intended only as asserting that such combinations have been discovered; there may be, and probably are, others. As it would require too much space and too many illustrations to give full explanations of the steps by which I have reached the conclusions given, I must take for granted that those interested in the subject will be able to test these from what is presented.

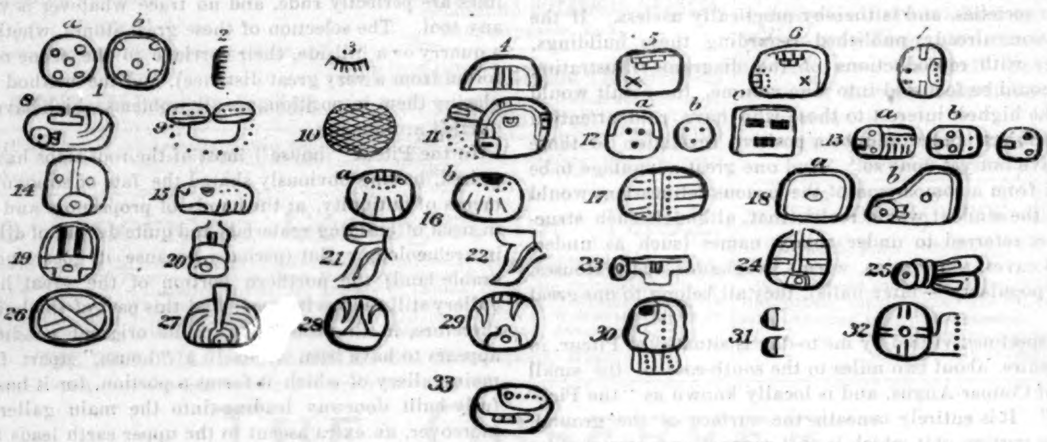


Fig. 1.

Letter Symbols (Fig. 1).

1 (a, b). *B'*.— I find no marks or rule by which to determine from the symbol alone the combined phonetic elements. This is Landa's character for *b* with a dot added.

2. *Ca*.— As a prefix, sometimes *ka* in the Cortesian Codex; *c* hard or *k* as final. Landa's character.

3. *C'*.— This is generally found in place of an eye where it denotes *cim*, *cin*, or *ci*.

4. *C'*.— *Ci* as a prefix, *ic*, *ich*, or *c* as a suffix or final.

5. *C'* or *K*.

6. *CH'*

—The characters 5 and 6 are quite variable and often difficult to determine because the complete form intended is not always given. In some instances the little dot-surrounded character at the left of 6 is solid, then a slightly different rendering appears to be demanded. Landa's *k* appears to be a combination of Nos. 3 and 5. The latter sometimes contains the dotted portion seen in 6. No. 6 is frequently found where it must be interpreted *che*, "wood," yet occurs without the dot-surrounded portion where it has the same signification. Other variants are found in the Dresden Codex.

7. *K'*.— Found as *ke* and *ek*, also as *Ce*.

8. *Ch'*.— Sometimes *chi*, as in the symbol for *Chikin*, "west;" *'Ch'* as final. Landa's first *x* appears to be an attempt to give this character which is the partially closed hand.

9. *KU'*.— Landa's symbol. This does not appear to be subject to any variations that affect its phonetic value.

10. *X'*.— Cross-hatching usually indicates *x* (sh) as the leading phonetic element; however, it is sometimes rendered by *ch'*, as is evident from its appearance in the symbol for the day Chicchan if we consider it phonetic. However, the day symbols cannot always be relied upon in this respect, as will be seen by what follows.

11. *X'*.— Landa's second *x* is substantially the same as this character. But he has taken two characters for one, as in this the *x* is represented by the dotted lines alone; the little loop at the forehead, or rather the little parallelogram, in it is *a*; the face character *n*. The whole character appears to be properly rendered by *xan*, "slowly, leisurely, gently." The chief variation in the combination is found in the loop at the forehead, which may be a vowel or consonant. This form of *x* is seldom found except in combination with *n*.

12 (a, b, c). *E* and *Ee*.— The variations are shown in 12b and 12c.

13 (a, b, c). *L'*.— This is Landa's first *l*. The variations are shown in 13b and 13c. Found in combination with different vowels, as *le*, *ol*, etc.

14. *L'*.— If Landa's second *l* be turned round it will be found to be a rude imitation of this character, which is the symbol for the day *Ahau*. *Li*, in the symbol for *Likin*, East; follows *ku*, etc.

15. *M'*,-*Me*.— Symbol for the day *Men*.

16 (a, b). *M'*.— Varies in having the little loops at the top, sometimes solid, as in 16b. The dot-surrounded portion of 16b is used alone in one series of the Cortesian Codex for this letter followed by *e*. The combinations have not been traced.

17. *M'*.— This appears to be another form of *m*, or *m*

doubled, or combined with *n*. Not satisfactorily tested as yet, though *m* is certainly the chief phonetic element.

18 (a, b). *M'* (?).—Although not thoroughly traced, I am satisfied that this character, which is the symbol of the day *Muluc*, has *m* as its chief phonetic element, generally with *o* or *u*. The part representing the *c* is omitted from the day symbol, but is found in the little ring and loops in 18b. The form of the contour of a character is generally of no significance as it may be round, square, or deeply notched without any change in its meaning.

FIG. 2.

19. *P* or *Pp* (?).— Although I have not tested this satisfactorily, I am certain from my examinations that its phonetic equivalent is *p* usually *pp*. There are some variations found chiefly in the lower portion. The *p* and *b* appear to be interchangeable in the Codices even in the same word; for example in the Dresden Codex 48c, we find the *b* character in the symbol for the month *Pop*, while on 50b it is replaced in the same month symbol by our No. 19.

20, 21, 22. *T'*.—These characters (20, 21 and 22) appear to have *t* as their chief phonetic element, varied according to the markings in the upper portion. No. 20 is also varied by the marks in the lower or middle circle.

23. *Th'*.— Is followed by *e* and *i*.

24. *Tz'*.— I am also inclined to believe that the two streamers or lines which extend upward in characters, as in the symbol for the month *Tzec*, indicate the presence of this sound.

25. *Z'*, *Za*.—Varied according to the markings in the wings and circle.

26. *ɔ* (dz).— Sometimes *z*.

27. *Y'*.— The index to the variations in the signification if there be any, which is doubtful, will probably be found in the length and form of the stem.

28. *Bal* or *bil* (?).—This is the symbol for the day Acbal.

29. *Ch* (?).— Usually followed by *o* or *u* when not terminal. Is the symbol for the day *Chuen*.

30. *Cab*.— The signification of the appendage so often found attached below this symbol has not been ascertained.

31. *H'*.— Sign of aspiration, the open ends always turned toward the character with which it is connected.

32. *Kin*.—Sometimes without the wing. The latter appears to be used for *n*, the circle for *ki*.

33. *Kal*.— If the separate elements are represented, it is probable the section with the dotted line stands for the *k* and the curved line with the two little teeth for the *l*.

Having submitted samples of my interpretation to Dr. H. T. Cresson of Philadelphia subsequent to the first notice, in *Science*, of my discovery, I am much pleased to learn that he has reached a similar determination as to some of these letter symbols by an independent method. As I was not aware until the publication of the article mentioned, that he was at work on the Maya characters, this agreement in our conclusions is highly gratifying, and serves to strengthen both in the conviction that we are making genuine progress in the solution of this difficult problem.

I give here a few interpretations of groups of compound characters to illustrate the combinations of the letter symbols.

Fig. 2 represents a group of four compound characters in the upper division of Pl. XXII* Codex Troano, to be read in this order: upper left, upper right, lower left, lower right; which we will number in the order given 1, 2, 3, 4.

The following is probably a substantially correct translation: (1) *U-Zabal*, (2) *U-le*, (3) *Cutz*, (4) *2-yaxkin*: "Set (or literally do the setting of) the snare for the turkey on the second day of Yaxkin." I can give no explanation of the little crosses above the symbol for Yaxkin. The prefix to No. 1 and to No. 2 is the character for *u*; the upper character in No. 1 appears to be the symbol for *z* reversed; the band across the lower character the *b* (possibly interchangeable with *p*). The figure below agrees very well with this interpretation.

FIG. 3.

The group shown in Fig. 3 is found in the lower division of plate 26 Cortesian Codex. The characters are taken and numbered in the same order as in Fig. 2. No. 1 is supposed with good reason to be a deity symbol, the name however undetermined. Assuming this to be correct, I translate the group as follows: (Deity) *xan yalcab kal-cab*, "As" or "in the name of (the deity) slowly gather the swarm of bees and inclose them in a hive."

The figure below shows a priest wearing the mask of the supposed deity hence we say "as."

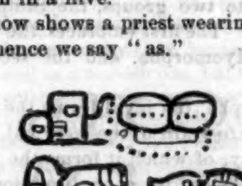


FIG. 4.

Fig. 4 is a group from the middle division of plate XXXII* Codex Troano. The characters are numbered in the same order as the preceding and are translated as follows: *Mulcin ku ci-* (god of death) *xaan*; "Collect together for the temple of the holy god of death palm wood." The picture below represents individuals bearing in their hands what appear to be blocks of wood on each of which is the symbol for *che* "wood."

The little character at the forehead in No. 4 is the symbol

for *aa* which is found in other combinations where it has the same signification.

So far I have found no marks indicating the plural; this may be represented by duplications.

OSTEOLOGICAL NOTES.

BY D. D. SLADE.

THE jugal arch is present in all of the order Rodentia, and is generally complete, although it exhibits many modifications in its composition. Three bones form the arch, which is straight or slightly curved horizontally, while it almost invariably presents a curvature downwards. The position of the jugal therein serves as a determining character in grouping the various families of the order.

The temporal fossa is often little developed, showing feeble energy in the action of the temporal muscle. On the contrary, the pterygoid plates and fossæ are often largely increased in relation to the enlarged development of the muscular insertions. In close connection with these conditions, the coronoid process of the mandible is small, and even rudimentary, while the parts about the angle are largely expanded. The condyle is little elevated and presents, with few exceptions, an antero-posterior articulating surface.

Post-orbital processes of the frontals exist in a few of the families, but there is in no case a corresponding process from the arch. The orbit is never separated from the temporal fossa.

In many of the rodents there is present a more or less extensive dilatation of the infra-orbital foramen, through which passes, in addition to the nerve, that portion of the masseter muscle which has its insertion upon the maxilla. This extends around the back of the jugal process of the maxilla in a pulley-like manner, to an insertion just below the socket of the mandibular præmolar, and thus co-operates with the temporal in moving the mandible in a vertical direction. This attachment of a head of the masseter is peculiar to the order, and explains the use of the vacuity in the maxilla which is oftentimes of vast relative proportions.

Assuming the present classification, all existing Rodentia may be brought into two groups, the Simplicidentata and the Duplicidentata. The first embraces the Sciuromorpha, Hystricomorpha, Myomorpha, and the second, the Lagomorpha.

In the Sciuromorpha, the jugal forms the greater part of the arch, extending forward to the lacrymal, and posteriorly to the glenoid cavity, of which it forms the outer wall, and it is not supported below by a continuation backwards of the process of the maxilla. In the more typical forms there is no enlargement of the infra-orbital opening, while the post-orbital processes of the frontals are characteristic of the family Sciuridæ. The external pterygoid plate is entirely wanting, and there is no fossa.

The jugal arch in the Myomorpha is for the most part slender, and the jugal, which does not extend far forward, is supported by the continuation below of the maxillary process. The zygomatic process of the squamosal is short. No post-orbital process of the frontal exists. The infra-orbital opening varies. In the family Muridæ, especially in the typical forms, this opening is perpendicular, wide above and narrow below, while the lower root of the zygomatic process of the maxilla is flattened into a thin perpendicular plate. Very much the same condition exists in the Myoxidæ, while in the Dipodidæ the foramen is as large as the orbit, rounded, and has a separate canal for the nerve. The malar ascends to the lacrymal in a flattened plate. In close connections with these conditions the coronoid process of the mandible is small and rudimenary, while the parts around the angle of the ramus are much developed.

In the Hystricomorpha the arch is stout. The jugal is not supported by the continuation of the maxillary process, and generally does not advance far forward. The infra-orbital vacuity is large, and is either triangular or oval. The coronary process and the condyle are but slightly elevated above the dental series.

In the Chinchillidæ the jugal extends forward to the lacrymal. In the Dasyproctidæ, Cœlogenys is characterized by the extraordinary development of the jugal arch, which presents an enormous vertical curvature, two-thirds of the anterior portion of which, constituting the maxilla, is hollowed out into a cavity which communicates with the mouth. The nerve passes through a separate canal, adjacent to the infra-orbital opening.

In the sub-order Duplicidentata, the jugal arch is well developed. In the family Leporidæ there are large wing-like, post-orbital processes, while the jugal, but feebly supported by the maxillary process, continues posteriorly to aid in the formation of the outer side of the glenoid articular surface, passing beneath the process of the squamosal.

In the Lagomyidæ there are no post-orbital processes, and the posterier angle of the jugal is carried backward nearly to the auditory meatus. The infra-orbital opening in the Duplicidentata is of the usual size. The angle of the jaw is rounded and the coronoid process much produced upwards.

In considering the significance of the jugal arch in the Rodentia, the peculiar vertical curvature downwards, which has already been noted, and which is a decided manifestation of weakness, must be taken into account. This condition is compensated in some of the families by the unusual arrangement made in the distribution of the muscular insertions of the masseter through the infra-orbital opening, by which increased energy is imparted to the powers of mastication, and whereby the action of the mandible is rendered fully equal to the demand upon its efforts.

In those families where the above condition does not exist it is evident that the strength of the arch is still sufficient for the antero-posterior movement of the articulation so peculiar to the Rodentia and so characteristic of the act of gnawing.

The relation of the arch to the neighboring parts must also be remarked. For example, the ascending ramus of the mandible differs according to the food. Elevated in the Leporidæ, it is short in the Sciuridæ, and still shorter in the Muridæ.

In the first the coronoid is broad, projects but slightly, is near the condyle, and far distant from the molar series, while the angle of the jaw is broad and well rounded, as in the Lagomyidæ.

In the other two families, squirrels and rats, the coronoid is feeble, pointed, and placed at equal distances between the condyle and the last molar; thus the masseter does not possess a leverage as advantageous as in the hare. This muscle, however, in the rats has its maxillary attachments much developed, while few fibres spring from the arch — a condition correlative with the feebleness of this last.

Cambridge, June 21.

NOTES AND NEWS.

THE recent publication is announced in *Nature* of the first number of a new monthly journal under the title *Rivista di patologia vegetale*. It is edited by Sigg. A. N. and A. Berlese, and published at Avellino, in Italy; and is to be devoted to the study of animal and vegetable parasites infesting cultivated plants, to the diseases which they cause, and the remedies employed to combat them.

—According to *Nature*, the Port Officer of Mangalore reports that a native craft was overtaken by heavy weather and made for Mangalore, where there is a bad bar with about eight feet of water on it. A tremendous sea was breaking over the bar, so, before crossing it, and while running in, the native skipper opened an oil cask, forming part of the cargo, and scattered it all round in the sea plentifully, with the result that he took his craft across the bar safely, and so saved the vessel and the cargo. The vessel's name was "Mahadeprasad," and she was of 95 tons, bound from Cochin to Bombay. This is said to be the first case on record of a native tindal who has successfully used oil in troubled waters.

—In *Science* of July 8, the closing paragraph of the article by Dr. C. V. Riley, on "The Number of Broods of the Imported Elm-leaf Beetle," should have read: "Our statement upon page 8 was a general one, based upon the observed shortness of the larval life, and upon the fact that the earliest larvæ mature before the end of May, and upon the additional fact that we know that newly developed beetles are found early in June. Prof. John B. Smith, in a paper read before the Entomological Club of the American Association for the Advancement of Science, in August of this year, made the statement that there is but one annual generation in New Jersey. The adult beetles develop from the larvæ which have fed during the summer, entering winter quarters as early as the first week in August. This state of affairs may probably hold in more northern regions, but in Washington it is safe to say that there are two generations, because, as just stated, newly developed beetles (the progeny of those which hibernate) appear in early June. These lay eggs, and, in fact, egg-laying may continue until the end of September, and larvæ have actually been found by Mr. Pergande in October."

—Mr. D. J. Macgowan, writing in the *Shanghai Mercury*, gives an account of some remarkable statements made by a group of Chinese traders who lately undertook a mercantile exploration of the interior of Southern Formosa. They started from Lamalan, which Mr. Macgowan takes to be Chockeday of the charts, and in seven days reached their objective point, Hualin Stream. They lodged in stone caverns, and the chattering of monkeys and the sounds of insects seemed to them "appalling and indescribable." The region was so "weird" that it reminded them of "legends of the kingdom of hobgoblins." Among the trees were some of "prodigious girth, forming a vast forest." These trees are said to measure more than ten outstretched arms. A tree said to flourish in the same forest is described as bearing "flowers, red and white, which are larger than a sieve, and of extraordinary fragrance." Mr. Macgowan adds: "Mr. Taylor, while searching for orchids, heard of these majestic trees and huge flowers, which he inferred, from what natives said, were epiphyte orchids. I am moved to make known this sylvan discovery in the hope that, pending the exploration of this *terra incognita* by our botanists, Dr. Henry or Mr. Ford, residents in Formosa will take measures to provide those naturalists with specimens of flowers, seeds, leaves, and bark of the trees concerning which the Chinese have excited our curiosity."

—"The New Decimal Association, whose headquarters are at Botolph House, Eastcheap," says the *London Daily Graphic* of May 14, "has memorialized the Lords of the Committee of Council on Education on the desirability of taking an important step in connection with the introduction of the metric system in this country. The May examinations of the Science and Art Department are known through the length and breadth of the land, and much has been done by means of these examinations to popularize and extend technical study. The memorial which has been presented recommends that in certain of the science examinations alternative questions be given in future, based on the metric system of measurement, which may be taken at the option of the candidate in lieu of questions based on feet and inches. In this way the large and intelligent class of candidates for certificates of the department will be induced to learn the metric system. The Committee of Council on Education has already ordered that the principles of this system should be taught in the higher standards of all elementary schools; and one of the steps taken by the school boards of London and other towns in consequence of this order has been to furnish the pupil teachers and advanced scholars with boxwood rules having a decimalized inch scale and a metric scale in juxtaposition. In addition to this, colored wall-charts of the metric weights and measures are used, and in this way the rising generation will to a great extent be prepared for the introduction of these weights and measures in future.

—The second annual geological expedition of the State University of Nebraska, undertaken by a party of six, left Lincoln for the field, June 21, 1892. This is known as the Morrill Geological Expedition, in honor of Charles H. Morrill, regent of the State University, whose liberality makes this work possible. The primary object of the expedition is the collection and preservation of geological specimens in general, but more particularly the palæontological forms for which the State and immediate surroundings are famous. The chief objective points are the Tertiary deposits of the White and Niobrara Rivers, and the Bad Lands of Nebraska, Wyoming, and South Dakota. The expedition is provided with tents,—furnished by Governor Boyd,—with teams and heavy covered wagons of the prairie-schooner type, and with apparatus, camping equipment, and provisions for the summer. The party consists of six members,—exclusive of guide,—Mr. Thomas H. Marsland, Frederick C. Kenyon, Arthur C. Morrill, and Harry H. Everett, all of the State University of Nebraska, and James H. Haines of Iowa College, together with Erwin H. Barbour, acting State geologist, as professor in charge. The "Fossil Corkscrew," or Daimonelix, beds were visited first, and some tons of these extraordinary new fossils—noticed and figured in *Science*, February, 1892—were obtained. Native lumber and hay for packing are carried, and specimens are boxed as found, and delivered at the nearest station or siding. At the close of the expedition these scattered collections will be brought together and delivered at the State University in cars, which the railroad companies have generously offered for that purpose.

—The eighth annual report of the Wisconsin Experiment Station devotes a large share of space to questions relative to ensilage. One chapter is devoted to a careful study, by F. H. King, of the construction and filling of silos. Mr. King, having visited 93 silos in Missouri, Michigan, Ohio, and Illinois, and several farmers while filling their silos, in order to obtain data for this chapter. Mr. King concludes that a stone silo, properly constructed, will keep the silage as well as a wooden one, but that it will be necessary to renew the cement lining frequently, or else to whitewash it with fresh cement every year, as the acids of the silage soon soften the cement. He finds that lath and plaster is a failure as a silo lining, both because of the softening of the plaster and the liability to injury with the fork in handling the silage. Of the wooden linings, that made by two thicknesses of boards with tarred paper between, all nailed firmly together, is showing greatest durability; but all wooden linings rot soon unless well ventilated. Painting the lining tends to hasten decay instead of preserving it. From an experiment in feeding corn silage in comparison with dry corn fodder, the following conclusions are reached: 1. A daily ration of four pounds of hay and seven pounds of grain feed, with corn silage or field-cured fodder corn *ad libitum*, fed to twenty cows during sixteen weeks, produced a total quantity of 19,813 pounds of milk during the silage period, and 19,801 pounds of milk during the fodder-corn period. 2. When we consider the areas of land from which the silage and fodder corn are obtained, we find that the silage would have produced 248 pounds more milk per acre than the dry fodder, or the equivalent of 12 pounds of butter. This is a gain of a little more than three per cent in favor of the silage.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

874 BROADWAY, NEW YORK.

SUBSCRIPTIONS.—United States and Canada.............. $3.50 a year.

Great Britain and Europe.................. 4.50 a year.

Communications will be welcomed from any quarter. Abstracts of scientific papers are solicited, and one hundred copies of the issue containing such will be mailed the author on request in advance. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

For Advertising Rates apply to HENRY F. TAYLOR, 13 Astor Place, New York.

A PLEA FOR A BROADER BOTANY.

BY L. H. BAILEY.

THE science of botany, as ordinarily considered and taught, has not laid hold of the full amount of territory to which it is entitled, and it has not, therefore, reached its full measure of usefulness. Strictly speaking, botany is the science of plants, but by general consent it appears to have dwarfed itself into a science of wild plants; or if it deals with cultivated plants they are such as fall to the care of botanical gardens, or, in other words, those which are cultivated for the sole purpose of maintaining a collection. It is not strange that in the earlier days botanists should have eliminated from their domain the whole realm of cultivated plants, for cultivation then meant little else than the maintenance and improvement of plants for merely economic purposes, and there was little science of cultivation. But now that the teachings of evolution have thrown a new purpose into the study of all natural objects, cultivated plants have acquired a fascinating interest from the abundant light which they throw upon variation and descent. In fact, aside from paleontology, there is no direction in which such abundant material can be found for the study of evolution as in cultivated plants, for in nearly all of them the variation is fully as great as in domesticated animals, while the species are very many times more numerous; and, by the fostering aid rendered by man, the accumulative effects of modified environment and selection are much more quickly seen — and therefore more intelligible — than in wild plants. My nearest neighbor, who is a paleontologist, and myself, a horticulturist, compare our respective fields of study to the decay and burning of a log. In both decay and burning the same amount of work is finally accomplished and the same amount of heat is evolved, but one process requires years, perhaps a century, for its accomplishment, and the other requires but a few hours. Cultivated plants afford within definite periods of time as much variation and progression as their wild prototypes exhibit in ages. So the garden is one of the best places in which to study evolution. It is a common opinion, to be sure, that the variation of cultivated plants is anomalous and uninstructive because influenced by man, but this is wholly erroneous. I have yet to find a variation in cultivated plants which can not be explained by laws already announced and well known. It is strange that one can ever believe that any variation of natural objects is unnatural!

But wholly aside from the fascinations of pure science, cultivated plants and cultivation itself demand the attention of the botanists, for horticulture is nothing more than an application of the principles of botany. Just now, mycology is making important additions to horticultural practice, but there are greater fields for the applications of an exact science of plant physiology, whenever that science shall have reached a proportionate development. In short, the possibilities in horticulture, both in science and practice, are just as great as they are in the science of botany upon which it rests; and inasmuch as it is absolutely impossible to separate horticulture and botany by any definition or any practical test, the two should go together in an ideal presentation of the science of plants. Horticulture belongs to botany rather than to agriculture.

The ideal chair or department of botany, therefore, should comprise, in material equipment, laboratories, botanic gardens, green-houses, orchards, vegetable and ornamental gardens, all of which should be maintained for purposes of active investigation rather than as mere collections; and I am sure that no department of botany can accomplish the results of which the science is capable until such breadth of equipment is secured. I am aware that there are difficulties in such a comprehensive field, but the only serious one is the lack of men. Botanists, as a rule, care little for gardens and cultivated plants, and horticulturists are too apt to undervalue the importance of scientific training and investigation; but the time cannot be far distant when men shall appear with sufficient scientific and practical training to appreciate the needs of the whole science and with enough executive ability to manage its many interests. Such men are no doubt teaching in some of our colleges to-day, were the opportunity open to them. One cannot be a specialist in all or even several of the many subjects comprised in this ideal, but he may possess the genius to encourage and direct the work of other specialists. The first need is the opportunity, for there is not yet, so far as I know, an ideal chair of botany in existence, where the science can be actively studied in its fullest possibilities and then be presented to the student and the world.

Cornell University.

THE LAWS AND NATURE OF COHESION.

BY REGINALD A. FESSENDEN.

DESIROUS of finding some relation between the conductivity of metals and their other physical properties, the writer, several years ago, began to tabulate all the data he could find. Realizing the uselessness of comparing the properties of substances whose natures are essentially different, as wood and iron, it was decided to confine the work to the elementary substances. It was found that the only elements whose properties were at all well known were those of the five chemical groups comprising the following metals: I., iron, nickel, cobalt, platinum, osmium, iridium; II., sodium, copper, silver, gold; III., magnesium, zinc, cadmium, mercury; IV., aluminium, thallium, indium, gallium; V., silicon, tin, lead.

The data collected were not very concordant, but when they had been compared and the most probable values taken, laying due stress on the purity of the substances examined and the standing

of the observer, various regularities or laws were at once apparent, and it is for the purpose of pointing out one of these that the following paper has been written.

This piece of paper, taken as a whole, has certain properties, a certain size, a certain weight, a certain motion, and is the seat of a certain force which attracts other ponderable bodies to it. A single atom of matter has its weight, motion, size, and force. The weights of the atoms form the basis of electrometric chemistry, their motion that of the kinetic theory of heat. To their size less attention has been paid, we have only Mendelejeef's curve and certain experiments of Roberts-Austen, who has showed that the tensile strength of gold is weakened, not in proportion to the weight of the metal alloyed with it, but to the volume, in the same way as ten lumps of gravel weaken a casting more than ten grains of sand. Of the force — the force of cohesion — still less is known, in fact absolutely nothing, and the object of this note is to point out what the nature of this force is and what its laws are.

In its early youth science was riotously extravagant of ethers, and any puzzling phenomenon was considered warrant enough for the creation of a new one. As it has grown older it has grown also more economical, until at the present day the scientist who should ask for an appropriation of a new ether, to help him out of a difficulty, would be pounced upon. For this reason, if no other, we will confine ourselves to examining the various means by which our present ether has been supposed capable of producing the forces which cause cohesion.

1. Gravitation. There have not been wanting eminent scientists who have considered that gravitation could account for cohesion, and there have been many ingenious theories proposed, for instance that of Watts, who supposed that (since the effects of gravity on the moon's path may be supposed to consist of two parts, one independent of the shape of the earth and varying inversely as the square of the distance, the other dependent on the shape and varying inversely as the cube of the distance) if the atoms were of irregular shapes it might account for the effects. But no theory with gravitation as its basis will hold, first, because the effects are much too small; second, because, as we shall see, the cohesive force is totally independent of the weights of the atoms and depends on the size only.

2. Condensation and rarifaction of the ether caused by the motion of the atoms. If we hold a pith ball near a tuning fork the pith ball will be attracted up to a certain distance, and will then be repelled if brought closer. This theory has been a favorite with many, but, as such an attraction would vary with the motion of the atoms in a way that we know the force of cohesion does not, it also must be dismissed.

3. Electricity. That the force of cohesion was due to electricity has long been vaguely suspected. On the same principle apparently that electricity was considered to be the cause of life, *i.e.*, "Life is a wonderful thing and unexplainable, electricity is a wonderful thing and unexplainable; therefore electricity is life" — the argument being possibly aided by an instinctive recollection of the Athenasion creed, which states that "there is only one incomprehensible." The writer is not aware that any evidence in favor of this theory was ever offered, so it was probably merely a guess.

Having rejected theories 1 and 2, we may see how the facts agree with the theory that cohesion is an electrostatic effect.

If we electrolyse a solution of silver nitrate, we know from Faraday's work that every atom of silver deposited on the electrodes carries over a certain quantity of electricity. This quantity is always the same, no matter how or when or where we perform the electrolysis, and this quantity seems to be related to the atoms in the same way as a pint of water to a pint measure. We may calculate the quantity on each atom in the following way. One cubic centimeter of silver weighs about 10.5 grammes One coulomb is carried over by every 1.12 milligrammes of silver deposited, therefore the charge on the atoms contained in one cubic centimeter of silver is $\frac{10500}{1.12} = 10^4$ coulombs.

As the sizes of the atoms vary from 10^{-7} to 10^{-8} centimeters in diameter, and silver is a small atom (½ the size of potassium), we may call its size 10^{-8} centimeters. In a cubic centimeter of silver then there would be 10^{24} atoms, which would give as the charge on each atom $10^4 \div 10^{24} = 10^{-20}$ coulomb. The capacity of an atom having a diameter of 10^{-8} centimeter is $\frac{10^{-8}}{18 \times 10^{11}} = 0.5 \times 10^{-20}$ farads.

The potential on each silver atom will therefore be about one volt. We may look at the cubic centimeter of silver as being made up of planes, each plane consisting of one layer of atoms. The distance between the centres of any two layers would be 10^{-8} centimeters. The potential on the atoms being one volt, the attraction between any two layers would be $\frac{4.5 \times 10^{-11} \times 1^2}{10^{-16}}$ grammes per cm² = 4500 kg. per cm² = calculated tensile strength of silver = 45 kg. per sq. mm.

From Wertheim's results we have observed tensile strength of silver 38 kg. per sq. mm. That the calculated and observed results should be so close is of course only a piece of good fortune. We had no right to expect it, as the data upon which the calculation is based are not known with sufficient accuracy. Still, the result is a remarkable one, and places beyond question the fact that the known electric charges on the atoms can produce effects of the same order as those observed.

Having shown this, we may follow up the theory by investigating in what way the cohesion of the metals would vary if this were the case. Evidently (since every atom, large or small, has the same quantity of electricity, and the larger the atoms of a metal the farther away the centres of the atoms would be) the cohesive force should be inversely proportional to some power of

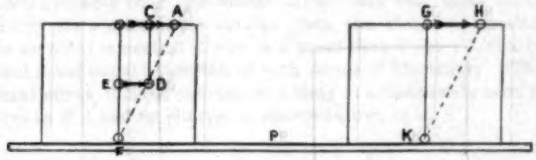


FIG. 1. FIG. 2.

the size (or atomic volume, as it is called, and which is got by dividing the atomic weight by the density of the substance). The following table shows this to be the case. In the first column are the names of the metals, in the second their relative sizes, or atomic volumes, in the third their rigidity, as given by Mr. Sutherland in the *Philosophical Magazine* of August, 1891:—

I.	II.	III.	IV.	V.
Iron	7.1	750×10^9	488×10^9	550×10^9
Copper	7.1	430	488	550
Zinc	9.2	330	314	340
Silver	10 2	280	270	270
Gold	10.2	270	270	270
Aluminium	10.4	250	250	260
Magnesium	14.	150	154	143
Tin	16.	136	122	100
Lead	18.	84	100	83
Cadmium	13.			170

As will be seen, the agreement is perfect, with the exception of iron, and those who are familiar how greatly the properties of iron are changed by the least particle of impurity will possibly agree with me in thinking that absolutely pure iron would be less rigid; in fact, some recent experiments show that it is so, being nearer 600 than 750; but I have not inserted this value, because a comparison with a set of observations made by one observer at one time and by one method would have a greater value than comparison with a lot of picked results from different observers.

Assuming the electrostatic theory, we can easily calculate the exact function which rigidity should be of the atomic volume in the following way.

Suppose Figs. 1 and 2 to represent two cubic centimeters of different elements, of which the atoms of one are twice the diameter of the other, or, to put it more accurately, the distance between centres of atoms is twice as great in the one case as in the

other. Let 1 contain the smaller atoms. Suppose one face made fast to the plank p, and both sheered slightly till they have the position shown by the dotted lines. It is evident that the ratio of work done in bringing the atom at G over to H to that done in bringing E to D, or C to A, will be the mean ratio of the force of attraction between K and G to that between E and F. This latter varies inversely as the square of the distance, according to the well-known electrical law, and, consequently, as the distance $G\,K$ is twice that of $E\,F$, the work done in moving E to D will be four times that done in moving G to H. Again, in Fig. 1 there will be 2^3 as many atoms to be displaced as in Fig. 2, so that, on the whole, there will be $2^3 + 2^2$ as much work done in displacing the cube in Fig. 1 as in Fig. 2. In other words, the rigidity will vary inversely as the fifth power of the distance between the centres of the atoms, or as (atomic volume)$^{\frac{5}{3}}$. Col. IV. gives the results calculated on this theory. As will be seen, they agree fairly well, as well as could be expected, considering the fact that we have left out one factor. This is the variation of rigidity with temperature, and as it would be obviously unfair to compare lead and silver at 600° C., it is obvious that our calculated results should only be applied when the metals are at some one point, say, at a temperature which is ½ the temperature of their melting-point. As those metals having the greatest atomic volume, as a rule, melt at lowest temperature (though there are many exceptions to this) we may make a rough sort of formula, which shall give the rigidity at ordinary temperatures by multiplying again by the atomic radius, so we get (atomic volume)^2 as the rate at which

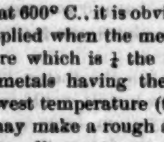


FIG. 3.

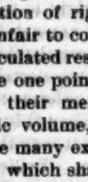


FIG. 4.

rigidity varies with size of atoms. Col. V. is calculated in this way from the rough formula :—

$$\text{Rigidity} = \frac{28 \times 10^{12}}{(\text{atomic volume})^2} \qquad \text{Equation I.}$$

The formula for Col. IV., and the more correct one, if we neglect variation of rigidity with temperature, is

$$\frac{12560 \times 10^9}{(\text{atomic volume})^{\frac{5}{3}}} \qquad \text{Equation II.}$$

The other moduli are related to that of rigidity. For if we represent Young's modulus by $\frac{1}{a}$, then the modulus of rigidity is represented by $\frac{1}{2\,(a+b)}$ and the bulk modulus by $\frac{1}{3\,(a-2b)}$, where b represents the lateral shortening accompanying the longitudinal lengthening a. So if b bears to a any constant ratio, then Young's modulus and the bulk modulus will each be some fraction of the modulus of rigidity. The continental writers, at least a good many of them, hold that $\frac{b}{a} = \frac{1}{4}$. Kelvin, Tait, and Stokes say there is no relation. On the one hand, it is certain that $\frac{b}{a}$ is not constantly equal to ¼. On the other hand, it does not follow that there is no relation between the two, and the evidence which has been brought to prove this has no value, for we have no right to argue from the facts that in india-rubber $\frac{b}{a} = \frac{1}{2}$, while in cork $\frac{b}{a} =$, say, $\frac{1}{100}$, that $\frac{b}{a}$ does not have any constant ratio in metals. The laws which govern the moduli of compounds and non-homogeneous substances like india-rubber and cork are not the same as those which govern homogeneous substances like gold and silver.

The following is a table of the metals and their Young's moduli. Col. I. contains the observed moduli taken from Sutherland's paper, and Col. II. contains the calculated values from the equation.

Equation III. $\text{Young's modulus} = \frac{78 \times 10^{12}}{(\text{atomic volume})^2}$ (corresponding to Equation I.).

Metals.	I.	II.
Iron	$2{,}000 \times 10^9$	$1{,}560 \times 10^9$
Copper	1,220	1,560
Zinc	930	920
Silver	740	750
Gold	760	750
Aluminium	680	690
Cadmium	480	465
Magnesium	390	395
Tin	420	295
Lead	190	235

There is only one metal which does not agree with theory, and that is tin (iron, of course, on account of its impurities does not, but we know that, as we obtain iron more pure, we find its rigidity less, so there is very little doubt but that if it were absolutely pure the agreement would be closer). But it is easy to show that the observed results of tin are wrong. For the rigidity is given as 136×10^9 and the Young's modulus as 420×10^9. Therefore, if we represent Young's modulus by $\frac{1}{a}$, then $\frac{1}{2\,(a+b)} = \frac{136}{420}$. Solving this we get $b = .55\,a$. Therefore the bulk modulus $\frac{1}{3\,(a-2b)}$ is negative, and the more tin is compressed the larger it swells, a result which is absurd. This will emphasize the fact that the agreement between theory and experiment is as close as that between the experiments themselves.

It will be noticed that the ratio-rigidity, Young's modulus, is about $\frac{28}{78}$. Therefore, as $\frac{1}{2\,(a+b)} = \frac{1}{2.7}$, Poisson's ratio for these metals is, on the average, 0.35. Therefore the bulk modulus = 1.1 times Young's modulus, which agrees with the only datum I find in Everett, i.e., Wertheims's figures for brass, which gives the ratio 9.48 : 10.2 = 1.08, very closely. All these moduli must contain the atomic volume to the same power, but this is not the case with the tensile strength; for, according to this electrostatic theory of cohesion, we may look at a wire as made up of thin discs, each disc consisting of a layer of atoms. The attractive force between any two such layers would vary inversely as the square of the distance between them and directly as the number of atoms in a layer. Combining these we find that it would vary as the fourth power of the atomic radius, or as (atomic volume)$^{\frac{4}{3}}$, making no allowance for the effect of temperature on the tensile strength. The following table gives in Col. I. the observed tensile strengths, taken from Wertheim for wires 1 millimeter in diameter; in Col. II. the atomic volumes of the elements, raised to the $\frac{4}{3}$-power; and in Col. III. the calculated tensile strengths, as found by the formula.

Equation IV. $\text{Tensile strength} = \frac{638}{(\text{atomic volume})^{\frac{4}{3}}}$ in kilograms for wires 1 millimeter in diameter.

Metal.	I.	II.	III.	IV.
Iron	65	13.7	48	2,000 (?)
Copper	41	13.7	48	1,327
Platinum	35	17.8	36	1,800 (?)
Zinc	15.77	19.3	33	690
Silver	29.6	22.2	29	1,223
Gold	28.46	22.2	29	1,318
Aluminium	18	23.2	27	898
Tin	3.40	41	15	504
Lead	2.36	47.8	13	600

Col. IV. contains the melting-points in degrees Centigrade from absolute zero. Here we have to deal with a much more

complicated phenomenon than that of rigidity. Rigidity is simply a function of the cohesive force. The tensile strength of a substance depends not only on the cohesive force of the metal, but also on its ability to resist flow. If a metal did not flow before being pulled apart, there is no doubt but that its tensile strength would be proportional to the $\frac{4}{3}$-power of the atomic volume. As, however, it does flow, and the amount of flow is not simply proportional to the diminishing of the cohesive force, we have to make a fresh allowance for it. In all the metals the melting-point is reached when the linear expansion has amounted to about 2 per cent. So when the cohesion has diminished about 4 per cent the atoms no longer hold the same relative positions, but one can slip in and take the place of another. So at equal distances from their melting-points only can the tensile strength be proportional to the $\frac{4}{3}$-power of the atomic volume. Consequently this ratio can only hold good with substances which have approximately the same melting-point. On examining the table, it will be seen that as copper, gold, and silver have approximately the same melting-point, the ratio does hold good with them. The same with tin and lead. Aluminium and zinc, which should be, the one slightly weaker, the other slightly stronger, than silver, have a melting-point about one-half that of gold and silver, and they have about half the strength at the temperature of comparison which they should have. The melting-point of iron and platinum is higher than that of gold or silver, and consequently their tensile strength is greater. The flow of a metal depends on two things, the cohesive force and the kinetic energy of the atoms. What function the flow is of the temperature, as reckoned in fractions of the temperature at which the substance melts, it is hardly worth while to go into now. If we suppose it directly proportional (though we may feel fairly certain it is not as simple a function) so that, at the same temperature, a metal melting at half the temperature that another does flows twice as easily, we get the following table, where Col. I. contains the observed tensile strengths, and Col. II. the calculated ones: —

Metal.	I.	II.
Iron	65	74
Copper	41	48
Platinum	35	48
Silver	29.6	29
Gold	28.5	29
Aluminium	18	18
Zinc	15.7	16
Tin	3.4	5
Lead	2.36	4

I have not been able to find any data on the tensile strength of magnesium. Theory gives about 9 kilograms for a wire 1 millimeter in diameter. It would be interesting to find if experiment confirms this.

If, when we have met with a new phenomenon in a substance, and are able to show that a certain property already known to exist in the substance is capable of producing effects of the magnitude observed, and that the phenomenon obeys the same laws as it would if it were caused by the already known physical property, we are to a certain extent justified in supposing that this property is really the cause of the phenomenon in question, and in applying our knowledge still further, we have seen that the charges which we know the atoms have on them are able to give effects of the same size as those observed in experiments on tensile strength, and that the various moduli follow the same laws as they would if cohesion were an electrostatic effect, and we may now apply our formula to other and less-known phenomena.

The velocity of sound in a wire is given by the formula: —

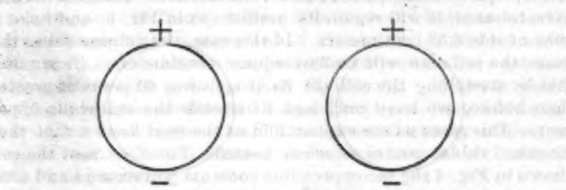
$$\text{Velocity} = \left(\frac{\text{Elasticity}}{\text{Density}}\right)^{\frac{1}{2}}.$$

Elasticity here means Young's modulus, the formula for which, as we have seen, was constant ÷ (atomic volume)^2, and atomic volume is atomic weight ÷ density, so we have velocity of sound in wire $= \left(\frac{\text{constant}}{\text{atomic weight} \times \text{atomic volume}}\right)^{\frac{1}{2}}$, the constant being 78×10^{13}. The following table gives in Col. I. the velocities of sound in wires of a number of metals which have been tested, and in Col. II. the calculated velocities for these and for other metals which have not yet been tested.

	I.	II.	III.
Silver	2.61×10^5	2.7×10^5	100
Copper	3.56	4.1	110
Gold	1.74	1.9	136
Alumin.		5.1	200
Magnes.		4.8	275
Zinc		3.6	374
Cadmium		2.8	450
Tin		2.0	878
Lead	1.23	1.4	1300

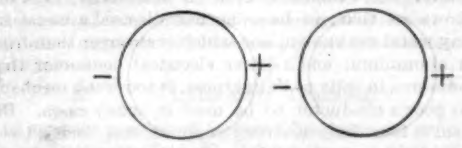
Col. III. gives the electrical resistance, silver being taken as 100, and it may be noticed that in any one group of metals the conductivity varies directly as the velocity of sound, and in passing from one group to another, by multiplying the conductivity by the valency we get proportionate values for all the metals. The same holds good for the heat conductivity. No close agreement can be expected here, for there are too many things to be taken into account. It is merely mentioned here because the fact of there being a relation between the velocity of sound and the conductivity for heat and electricity throws a light on the nature of these phenomena. This will form the subject of a separate paper. It may be asked *how* an electrostatic force can produce such effects. If the atoms are all similarly charged either + or − they would repel each other and not attract. The explanation is probably this: The atoms, if we may call them so, of electricity are not infinitely smaller than the atoms of matter. When an atom is neutral it does not mean that it has no charge but that it has equal quantities of both kinds of electricity. The resultant effect of these charges on a body at a distance is zero, it behaves as if it had no charge, as shown below, in *A*.

A



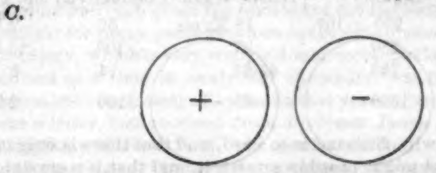
If the atoms be brought close together there is a state of unstable equilibrium, and the effect is that either the charges move on the surface of the atoms or the atoms themselves move so that the atoms attract each other, as in *B*. Consequently all atoms

B



neutrally charged attract each other. If nothing further happens the attraction is simply cohesion. If, however, any third substance connects the two outside parts of the atoms and so enables these parts to neutralize each other we have chemical combination, and the two atoms when separated show opposite charges, as in *C*.

C



Whether we accept the electrostatic theory of cohesion or not, from the above tables of moduli, the following laws are evident.

I. In any two metals the force of cohesion varies inversely as the square of the distance between the centres of their atoms.

II. In any one metal the force of cohesion varies inversely as the square of the distance between the centres of its atoms.

We may expect these facts to be of great use in the study of the properties of matter. For, knowing the size and weight of the atoms and the velocity with which they move, all that was wanting to enab e us to calculate the behavior of the atoms of matter, in the same way as we do the motions of the planets, was a knowledge of the laws of the force which holds them together; and, from the evidence given above, I have no doubt that you will agree with me in saying that we have at least made a beginning in that direction.

A few words might be said about Poisson's ratio. It is, as I said, not fair to argue from the behavior of cork or india rubber that there is no relation between longitudinal extension and lateral contraction or between a and b. When we compress a cork we are not compressing the substance which forms the cork any more than we are compressing a piece of paper when we crumple it up in our han l. A cork is like a dry sponge, and when we squeeze a sponge up in our hand we are simply doubling up the cell-walls, not compressing the substance of the sponge. The only way in which we can determine the compressibility of cork is to soak it in ether or some substance which fills all its pores and then subject it to hydrostatic pressure. In the same way when we stretch india rubber, or ivory or jelly, the longitudinal extension of the piece of rubber is not in the least a measure of the longitudinal extension of the substance of the rubber. All such substances are made up of two parts; rubber, for instance, of a hard elastic skeleton insoluble in most solvents, and of a soft plastic substance, soluble in many solvents, by use of which the two parts may easily be separated, similarly ivory and jelly. Let us take a square cell as in Fig. 3, the walls of which are of elastic material and the contents an incompressible plastic substance. Suppose it to be extended till its length is 4 centimeters and its breadth and thickness each 2 centimeters, as in Fig. 4. The total area of cell-wall is 40 square centimeters, and the total volume of incompressible contents is 16 cubic centimeters. Imagine the cell to be released, it will regain its position as in Fig. 3, and form a cube of side 2.52 centimeters. In this case, the volume being the same, the cell area will be 38.1 square centimeters. So we find that by stretching the cell till its length was 60 per cent greater than before, we have only had to stretch the cell-walls 5 per cent. This gives us the explanation of the well-known fact that stretched rubber contracts when heated. For if we heat the cell shown in Fig. 4 the incompressible contents will expand and tend to make the cell-walls take that shape in which they can hold the most. This is obviously that of the original cube, therefore the result will be a contraction.

Of course the formulæ, derived from this theory of cohesion, give us the means of calculating the physical properties of metals which have never been examined, or even discovered. For example, it shows us that we have at our disposal a metal far superior to any metal yet known, one which is stronger than iron, lighter than aluminium, and a better electrical conductor than silver. Aluminium, in spite of its lightness, is too weak mechanically and too poor a conductor to be used in many cases. But this new metal is four times as strong as aluminium, and is twice as good a conductor of electricity. The metal referred to is glucinum or beryllium. All that is known about it is that it has an atomic weight of 9.1 and a density of 1.7 to 2, the exact figures not being known. But from these scanty data we can deduce the following figures:

Metal	Rigidity	Tensile st'gth	Conductivity	Sp. gr.
Alumin.	250×10^9	18 Kgms	50	2.75
Silver	280	27	100	10.5
Iron	750	42-65	14	8
Calculated for Glucinum	1300	65	105	2

We also see why diamond is so hard, and that there is only one other thing that might possibly scratch it, and that is a crystal of manganese. With the exception of glucinum, none of the other metals, either discovered or to be discovered, are likely to be any better than those we have now.

NOTES ON LOCAL HEMIPTERA-HETEROPTERA.

BY E. B. SOUTHWICK, PH.D.

IN the CORISIDÆ *Corisa Harrisii* Uhl. is very common in our park lakes, and the drag-net brings many of them to land at every haul. Another species as yet undetermined is about one-third the size of *Harrisii*, and equally abundant.

In NOTONECTIDÆ *Notonecta undulata* Say. is very common. This was at one time known as *variabilis* Fieb., a name quite appropriate, for they are variable to a marked degree, some of them being nearly white, while others are very dark. *Notonecta irrorata* Uhl. is also common, and is a very beautiful insect, and more uniform in coloration.

In NEPIDÆ *Ranatra fusca* Pal. Beauv. is our only representative, as far as my observation goes; this was at one time known as *R. nigra* H. Schf.

In BELOSTOMATIDÆ we have two species. *Benacus griseus* Say., that giant among Hemiptera. This much-named creature has been known as *B. haldemanus* Leidy, *B. harpax* Stal., *B. ruficeps var.* Duf., *B. distinctum* Duf., and *B. augustatum* Guer.; but at last has settled down to *B. griseus*, which name, I hope, gives credit where it belongs. *Zaitha fluminea* Say. is very common in our lakes, and the females are often taken with their backs completely covered with eggs, deposited in regular rows upon the elytra; at the same time the young of all sizes will be brought up with the drag-net.

In the family HYDRODROMICA and sub-family SALDIDÆ I have but one representative species, *Salda orbiculata* Uhl., and it is exceedingly rare.

In the sub-family HYDROBATIDÆ I have taken three species, viz., *Limnoporus rufoscutellus* Lat., *Limnotrechus marginatus* Say., and *Hygrotrechus remigis* Say; they are all about equally common on the waters of our lakes and in ditches and pools.

In the family REDUVIDÆ the sub-family PIRATINA is represented by *Melanolestes picipes* H. Schf., which is quite common under stones along with *Carabidæ*.

In the sub-family REDUVIINA we have three species. *Diplodus luridus* Stal. is very common with us, but in Professor Uhler's list it is only given as from Mexico. *Acholla multispinosa* is also common; this has been known as *A. sexspinosus* Wolff., and *A. subarmatus* H. Schf.

Sinea diadema Fabr. is not rare with us; this insect has had a number of names, and has been studied as *S. multispinosus* De G., *S. hispidus* Thunb., and *S. raptatorius* Say. I have a pair of insects from this State labelled *Harpactor cinctus* Fabr., which are probably what is now known as *Milyas cinctus* Fab. They are of a beautiful pinkish-white color, and have the limbs banded with black.

In the sub-family CORISINA three species of *Coriscus* are represented. *Coriscus subcoleoptratus* Kirby, a very common and curious insect, and formerly known as *C. canadensis* Prov., *C. annulatus* Reut, which is very rare, and *C. ferus* Linn, rather common.

In the family PHYMATIDÆ the sub-family PHYMATINA is represented by that very common and curious insect *Phymata Wolffii* Stal. *Phymata erosa*, which is quoted as common throughout the State of New Jersey, I have never found here.

In the family TINGITIDÆ and sub-family TINGITINA I have *Corythuca arquata* Say. as one of the most common. This species of Tingis is found on the butternut, and was at one time known as *Tingis juglandis* Fitch, and Dr. Riley found it on the white oak.

Corythuca ciliata Say, formerly known as *Tingis hyalina* H. Schf., is, I believe, the one so common on the buttonwood, *Platanus*. I have a species taken from the paper mulberry *Broussonetia* and another species from *Stophylea*, both new to me.

In the family ACANTHIDÆ and sub-family CIMICINA we have *Acanthia lectularia* Linn., which is very abundant and well distributed all over our city. In the family CAPSIDÆ we are quite well represented. *Plagiognathus obscurus* Uhl. is very common. *Episcopus ornatus* Reut is quite rare; I have only taken about a dozen specimens. *Garganus fusiformis* Say is rather common, and *Hyaliodes vitripennis* Say is exceeding rare.

Capsus ater Linn. is also rare, but is conspicuous on account of its shining black color. *Orthops scutellatus* Uhl. is very rare indeed; I have only taken about half a dozen specimens. *Comptobrochis grandis* Uhl. is also very rare. *Poecilocapsus goniphorus* Say. is very common; this has been known as *P. dislocatus* Say and *P. melaxanthus* H. Schf. *P. lineatus* Fabr. is more common than *goniphorus*, and destroys a great variety of plants. *Poeciloscytus basalis* Reut., formerly known as *P. sericeus* Uhl., is also common. *Lygus pratensis* Linn., which much resembles the last, is exceedingly common; this was formerly known as *L. lineolaris* Pol. Beauv, and *L. oblineatus* Say. *Calocoris rapidus* Say. is common, and was formerly known as *C. multicolor* H. Schf. *Neurocolpus nubilis* Say. is very rare with us; I have but three specimens representing it. *Phytocoris eximius* Reut. is also very rare, and a species of *Phytocoris*, not determined, more common. *Lopidea media* Say. is very rare, as is *Resthenia insignis* Say. *Collaria meilleurii* Prov., which Uhler gives as *Trachelomiris meilleurii* Prov., is quite rare. *Leptopterna dolobrata* Linn. is common everywhere where there are grass and weeds. *Miris offinis* Reut., formerly known as *M. instabilis* Uhl., is not common. *Trigonotylus ruficornis* Fall. is rare with us, making about twenty species of CAPSIDÆ taken here, which is probably only about one-third of the species that occur with us.

OBSERVATIONS AT BOSSEKOP.[1]

THE close connection between the Aurora and magnetism induced Herr O. Baschin to accompany Dr. Brendel to Bossekop for the purpose of observing this phenomenon. On January first of this year they entered the Alten Fiord, at the end of which lies Bossekop. It is built on the slope of one of the raised beaches so common on the shores of the fiord and in the adjacent valleys. An elevation of the shore amounting to 43 inches is said to have taken place during the last fifty years, but the calculations are not beyond suspicion. Dr. Brendel succeeded in obtaining photographs of different forms of the Aurora, the only ones at present in existence. Violent magnetic disturbances have often been observed during displays of the Northern Lights, and the close relation of these phenomena is further demonstrated by the fact that the centres of the arcs of light lie on the magnetic meridian, and that the corona, the most splendid form of Aurora, lies in the magnetic zenith. The most remarkable disturbances took place on February 14, accompanied by an unusually gorgeous display of the Aurora, when the magnetic declination was observed to vary more than 12° — the greatest deviation ever noticed — within eight minutes. At the same time the disturbances in Europe and North America were so great that most of the self-registering instruments were unable to record them. It is not possible at present to determine with certainty the cause of these striking phenomena, but it seems probable that the great sun-spot, seventeen times as large as the surface of the earth, which was at the time visible even to the naked eye, was connected with the disturbances mentioned.

The meteorological observations also presented much that was interesting. The temperature on the west coast of Norway does not fall nearly so low as might be expected in such high latitudes. Even at the North Cape the mean of the coldest month is only 23° F., whereas in West Greenland on the same latitude the temperature sinks every winter to − 40°. As, however, the distance from the coast increases, the temperature falls rapidly. The minimum observed at Gjesvar, near the North Cape, is − 2° F.; at Bossekop, 33 miles from the open sea, − 22°; and at Karasjok, further south but 120 miles from the coast, − 60°. Thus the influence of the Gulf Stream, which prevents the fiords from freezing over, does not penetrate inland. The fall of snow in winter is not very large at Bossekop, but also increases towards the interior. In very cold weather the snow does not come down in flakes, but takes the form of crystals of ice, which, having no cohesion, are blown about by every puff of wind.

The Lapps may be divided into two classes, — the very poor fishermen of the coast and the nomadic Lapps of the mountains, who often possess considerable property. Of late years a third class has sprung up, which has settled in two inland places, Karasjok and Kautokeino. At the beginning of March the Lapps gather to a great fair at Bossekop, where many thousand ptarmigan, several tons of reindeer flesh, besides butter and tongues, change hands. Herr Baschin drove to Karasjok in a reindeer sledge, a vehicle that requires a deal of management, in order to inspect the dwellings of the Lapps settled there. The village is situated on a stream of the same name, one of the headwaters of the Tana, the second largest river of Norway, and contains about 200 inhabitants — all, with few exceptions, Lapps. Their dwellings are conical tents, 13 to 16 feet in diameter, with openings at the top to let out the smoke from the fire in the centre. Many Lapps own 2,000 to 3,000 head of reindeer. These people are not so powerful, intelligent, and honest as the Eskimo, and give the Norwegian Government much trouble through their propensity to steal reindeer. In Karasjok Herr Baschin found Balto and Ravna, the two Lapps who accompanied Dr. Nansen on his journey across Greenland, and on his voyage home he inspected that explorer's new vessel, which is being built at Laurvig. It has a nearly semi-circular cross-section, and is rigged as a three-masted schooner. It is of 250 tons register, and is constructed almost entirely of German oak. A small engine will enable it to make six knots an hour during calms.

[1] From the Scottish Geographical Magazine.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Laboratory Teaching.

IN a recent number of *Science* there appeared an excellent article by Professor Chas. F. Mabery upon "Aims of Laboratory Teaching," in which occurred the following sentence: "Probably the earliest attempt in this country to give systematic laboratory instruction, to classes of any magnitude, was made in 1865 at the Massachusetts Institute of Technology."

Professor Mabery is surely in error upon this point, as such instruction had been given the students of the Rensselaer Polytechnic Institute for many years previous to the date quoted. Our present laboratory, which is very complete and accommodates seventy-six students at a time in analytical chemistry, was built in 1862, to replace the one destroyed by fire in that year. Permit me to quote from a letter just received from Professor James Hall, geologist of the State of New York, who graduated from this institution many years ago: "In regard to systematic laboratory instruction in chemistry, I can only say that when I entered the Rensselaer School in 1831 there were already laboratories fitted up for giving systematic instruction in chemistry, and each student of the class

was required to do laboratory work, and to prepare himself his material and apparatus, to give each day during the course an extemporaneous lecture, illustrated by experiments, and full explanation of the phenomena and the laws governing them. Every student was well grounded in the principles and elements of the science, and by a method of teaching never surpassed, if ever equalled, by any other." WILLIAM P. MASON.

Troy, N.Y., July 29.

AMONG THE PUBLISHERS.

THE ninth annual issue of "The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland" has recently been issued by Charles Griffin & Co., Exeter Street, Strand, London. The present issue gives a well-edited chronicle of the work done during the past year by the learned societies of Great Britain and Ireland, together with lists of the officers and a brief statement of the history and purposes of the organizations. The lists of the papers are quite complete, most of the society secretaries having given the needed information, and make a showing of scientific and literary activity with which we have as yet but little to compare in America. The hand-book is well made for its purpose, and would prove an excellent book of reference in American libraries.

— A vigorous statement of the scientific principles upon which the treatment of criminals should be based will open *The Popular Science Monthly* for August. It is by Professor Edward S. Morse, who takes as his title "Natural Selection and Crime." The Warfare of Science papers, by Dr. Andrew D. White, will be continued with a chapter on "Geography," in which are given the various mythological and theological ideas concerning the form of the earth and the proper mode of representing it that have prevailed in ancient and mediæval times. "The Manufacture of Boots and Shoes" will be described by George A. Rich. This is one of the illustrated series of Articles on American Industries, and, in both the text and the pictures, tells a story of wonderful progress. An ethical study on "Veracity," by Herbert Spencer, will be among the contents.

— The Geographical Society of Germany will shortly publish a volume commemorative of the four-hundredth anniversary of the discovery of America by Columbus, which will, it is said, be one of the most elaborate publications ever issued by the society. Dr. Konrad Kretschmer, the editor of the forthcoming work, has visited all the principal libraries of Italy in search of material, and has had access to many rare manuscripts hitherto unused. The memorial volume will contain forty five maps relating to the discovery of America, thirty-one of which are said to have never been published. Emperor William has contributed 15,000 marks

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

Taxidermist going out of business has quantity of finely-mounted specimens of North American birds, mammals and reptiles and skins of birds for sale, including a full local collection of bird skins, showing some great variations of species; also quantity of skulls with horns of deer and mountain sheep, and mounted heads of same. Will give good exchange for Hawk Eye camera with outfit. Apply quickly to J. R. Thurston, 265 Yonge St., Toronto, Canada.

For exchange.—A fine thirteen-keyed flute in leather covered case, for a photograph camera suitable for making lantern slides. Flute cost $27, and is nearly new. U. O. COX, Mankato, Minn.

To exchange; Experiment Station bulletins and reports for bulletins and reports not in my file. I will send list of what I have for exchange. P. H. ROLFS, Lake City, Florida.

Finished specimens of all colors of Vermont marble for fine fossils or crystals. Will be given only for valuable specimens because of the cost of polishing. GEO. W. PERRY, State Geologist, Rutland, Vt.

For exchange.—Three copies of "American State Papers Bearing on Sunday Legislation," 1891, $2.50, new and unused, for "The Sabbath," by Harmon Kingsbury, 1840; "The Sabbath," by A. A. Phelps, 1842; "History of the Institution of the Sabbath Day, Its Uses and Abuses," by W. L. Fisher, 1859; "Humorous Phases of the Law," by Irving Browne; or other works amounting to value of books exchanged, on the question of governmental legislation in reference to religion, personal liberty, etc. If preferred, I will sell "American State Papers," and buy other books on the subject. WILLIAM ADDISON BLAKELY, Chicago, Ill.

For Sale or Exchange for books a complete private chemical laboratory outfit. Includes large Becker balance (200g. to 1-10mg.), platinum dishes and crucibles, agate motors, glass-blowing apparatus, etc. For sale in part or whole. Also complete file of *Silliman's Journal*, 1862-1885 (62-71 bound); Smithsonian Reports, 1854-1883; U. S. Coast Survey, 1854-1869. Full particulars to enquirers. F. GARDINER, JR., Pomfret, Conn.

Wanted, in exchange for the following works, any standard works on Surgery and on Diseases of Children: Wilson's "American Ornithology," 3 vols.; Coues' "Birds of the Northwest" and "Birds of the Colorado Valley," 2 vols.; Minot's "Land and Game Birds of New England;" Samuels' "Our Northern and Eastern Birds;" all the Reports on the Birds of the Pacific R. R. Survey, bound in 2 vols., morocco; and a complete set of the Reports of the Arkansas Geological Survey. Please give editions and dates in corresponding. R. ELLSWORTH CALL, High School, Des Moines, Iowa.

To exchange Wright's "Ice Age in North America" and Le Conte's "Elements of Geology" (Copyright 1882) for "Darwinism," by A. R. Wallace, "Origin of Species," by Darwin, "Descent of Man," by Darwin, "Man's Place in Nature," Huxley, "Mental Evolution in Animals," by Romanes, "Pre-Adamites," by Winchell. No books wanted except latest editions, and books in good condition. C. S. Brown, Jr., Vanderbilt University, Nashville, Tenn.

Wants.

Any person seeking a position for which he is qualified by his scientific attainments, or any person seeking some one to fill a position of this character, be it that of a teacher of science, chemist, draughtsman, or what not, may have the 'Want' inserted under this head FREE OF COST, *if he satisfies the publisher of the suitable character of his application. Any person seeking information on any scientific question, the address of any scientific man, or who can in any way use this column for a purpose consonant with the nature of the paper, is cordially invited to do so.*

A JOHNS HOPKINS graduate (1892) desires a position as instructor in mathematics and physics. Address A. B. TURNER, Johns Hopkins University, Baltimore, Md.

WANTED.—A collection of postage stamps; one made previous to 1870 preferred. Also old and curious stamps on original letters, and old entire U S. stamped envelopes. Will pay cash or give in exchange first-class fossils, including fine crinoids. WM. F. E. GURLEY, Danville, Ill.

WANTED.—To purchase laboratory outfit; balances, evaporating dishes, burettes, etc., wanted immediately for cash. C. E. SPEIRS, 3 Murray street, New York. P. O. Box 1741.

WANTED.—The services of a wide-awake young man, as correspondent, in a large manufacturing optical business; one preferred who has a thorough knowledge of microscopy and some knowledge of photography. Address by letter, stating age and references. Optical, care of Science, 874 Broadway, New York.

WANTED.—We want any and all of the following, providing we can trade other books and magazines or buy them cheap for cash: Academy, London, vol. 1 to 28, 35, Jan. and Feb., '89; Age of Steel, vol. 1 to 66; American Antiquarian, vol. 1, 2; American Architect, vol. 1 to 6, 9; American Art Review, vol. 3; American Field, vol. 1 to 21; American Geologist, vol. 1 to 6; American Machinist, vol. 1 to 4; Art Amateur, vol. 1 to 7, Oct., '4; Art Interchange, vol 1 to 9; Art Union, vol. 1 to 4, Jan., '44, July, '6; Bibliotheca Sacra, vol 1 to 46; Godey's Lady's Book, vol. 1 to 20; New Englander, vol. 11; Zoologist, Series 1 and 1, Series 3 vol. 1 to 14; Allen Armendale (a novel). Raymer's "Old Book" Store, 243 4th Ave. S., Minneapolis, Minn.

WANTED.—By a young man, a Swarthmore College junior, a position as principal of a public high school in one of the Gulf States, or as instructor in botany, physiology, and geology in an academy or normal school. Address B., care of Librarian, Swarthmore College, Penn.

WANTED.—To act as correspondent for one or two daily or weekly papers. Have worked on paper for about two years Would like a position on editorial staff of humorous paper. Address GEO. C. MASON, 14 Elm St., Hartford, Conn.

TRANSLATOR wanted to read German architectural works at sight (no writing). One familiar with technical terms desired. Address "A.," Box 149, New York Post Office.

towards the expenses of publication, etc., and the work will undoubtedly be a most valuable contribution to the early history of America. It is expected that it will leave the government printing office early in August.

—In a capital address on "tooth culture," delivered at the annual meeting of the Eastern Counties Branch of the British Dental Association, and printed in *Lancet*, Sir James Crichton-Browne referred to a change which has taken place in bread, as one of the causes of the increase of dental caries. So far as England is concerned, this is essentially an age of white bread and fine flour, and it is an age therefore in which we are no longer partaking, to anything like the same amount that our ancestors did, of the bran or husky parts of wheat, and so are deprived to a large degree of a chemical element which they contain — namely, fluorine. The late Dr. George Wilson showed that fluorine is more widely distributed in nature than was before his time supposed, but still, as he pointed out, it is but sparingly present where it does occur, and the only channels by which it can apparently find its way into the animal economy are through the siliceous stems of grasses and the outer husks of grain, in which it exists in comparative abundance. Analysis has proved that the enamel of the teeth contains more fluorine, in the form of fluoride of calcium, than any other part of the body, and fluorine might, indeed, be regarded as the characteristic chemical constituent of this structure, the hardest of all animal tissue, and containing 95 5 per cent of salts, against 72 per cent in the dentine. As this is so, it is clear that a supply of fluorine, while the development of the teeth is proceeding, is essential to the proper formation of the enamel, and that any deficiency in this respect must result in thin and inferior enamel. Sir James Crichton-Browne thinks it well worthy of consideration whether the reintroduction into our diet of a supply of fluorine in some suitable natural form — and what form, he asks, can be more suitable than that in which it exists in the pellicles of our grain stuffs? — might not do something to fortify the teeth of the next generation.

QUERY.

Can any reader of *Science* cite a case of lightning stroke in which the dissipation of a small conductor (one-sixteenth of an inch in diameter, say,) has failed to protect between two horizontal planes passing through its upper and lower ends respectively? Plenty of cases have been found which show that when the conductor is dissipated the building is not injured to the extent explained (for many of these see volumes of Philosophical Transactions at the time when lightning was attracting the attention of the Royal Society), but not an exception is yet known, although this query has been published far and wide among electricians.

First inserted June 19. No response to date.

N. D. C. HODGES,
874 BROADWAY, NEW YORK.

TO THE READERS OF SCIENCE

PUBLISHER'S ANNOUNCEMENT.

Titles of Some Articles Published in *Science* since Jan. 1, 1892.

Aboriginal North American Tea.
Actinism.
Agriculture, Experimental, Status of.
Amenhotep, King, the tomb of.
Anatomy, The Teaching of, to Advanced Medical Students.
Anthropology, Current Notes on.
Architectural Exhibition in Brooklyn.
Arsenical Poisoning from Domestic Fabrics.
Artesian Wells in Iowa.
Astronomical Notes.
Bacteria, Some Uses of.
Botanical Laboratory, A.
Brain, A Few Characteristics of the Avian.
Bythoscopidæ and Cercopidæ.
Canada, Royal Society of.
Celts, The Question of the.
Chalicotherium, The Ancestry of.
Chemical Laboratory of the Case School of Applied Science.
Children, Growth of.
Collection of Objects Used in Worship.
Cornell, The Change at.
Deaf, Higher Education of the.
Diphtheria, Tox-Albumin.
Electrical Engineer, The Technical Education of.
Eskimo Throwing Sticks.
Etymology of two Iroquoian Compound Stems.
Eye-Habits.
Eyes, Relations of the Motor Muscles of, to Certain Facial Expressions.
Family Traits, Persistency of.
Fishes, The Distribution of.
Fossils, Notice of New Gigantic.
Four-fold Space, Possibility of a Realization of.
Gems, Artificial, Detection of.
Glacial Phenomena in Northeastern New York.
Grasses, Homoptera Injurious to.
Great Lakes, Origin of the Basins of.
"Healing, Divine."
Hemipterous Mouth, Structure of the.
Hofmann, August Wilhelm von.
Hypnotism among the Lower Animals.
Hypnotism, Traumatic.
Indian occupation of New York.
Infant's Movements.
Influenza, Latest Details Concerning the Germs of.
Insects in Popular Dread in New Mexico.
Inventions in Foreign Countries, How to Protect.
Inventors and Manufacturers, the American Association of.
Iowa Academy of Sciences.
Jargon, The Chinook.
Jassidæ; Notes on Local.
Keller, Helen.
Klamath Nation, Linguistics.
Laboratory Training, Aims of.
Lewis H. Carvill, Work on the Glacial Phenomena.
Lightning, The New Method of Protecting Buildings from.
Lissajou's Curves, Simple Apparatus for the Production of.
Maize Plant, Observations on the Growth and Chemical Composition of.
Maya Codices, a Key to the Mystery of.
Medicine, Preparation for the Study of.
Mineral Discoveries, Some Recent, in the State of Washington.
Museums, The Support of.
Palenque Tablet, a Brief Study of.
Patent Office Building, The.
Physa Heterostropha Lay, Notes on the Fertility of.
Pocket Gopher, Attempted Extermination of.
Polariscopes, Direct Reflecting.
Psychological Laboratory in the University of Toronto.
Psychological Training, The Need of.
Psylla, the Pear-Tree.
Rain-Making.
Rivers, Evolution of the Loup, in Nebraska.
Scientific Alliance, The.
Sistrurus and Crotalophorus.
Star Photography, Notes on.
Star, The New, in Auriga.
Storage of Storm-Waters on the Great Plains.
Teaching of Science.
Tiger, A New Sabre-Toothed, from Kansas.
Timber Trees of West Virginia.
Tracheæ of Insects, Structure of.
Vein-Formation, Valuable Experiments in.
Weeds as Fertilizing Material.
Will, a Recent Analysis of.
Wind-Storms and Trees.
Wines, The Sophisticated French.
Zoology in the Public Schools of Washington, D. C.

Some of the Contributors to *Science* Since Jan. 1, 1892.

Aaron, Eugene M., Philadelphia, Pa.
Allen, Harrison, Philadelphia, Pa.
Baldwin, J. Mark, University of Toronto, Canada.
Barnes, Charles Reid, Madison, Wis.
Baur, G., Clark University, Worcester, Mass.
Beal, W. J., Agricultural College, Mich.
Beals, A. H., Milledgeville, Ga.
Beauchamp, W. M., Baldwinsville, N.Y.
Boas, Franz, Clark University, Worcester, Mass.
Bolley, H. L., Fargo, No. Dak.
Bostwich, Arthur E., Montclair, N.J.
Bradley, Milton, Springfield, Mass.
Brinton, D. G., Philadelphia, Pa.
Call, E. Ellsworth, Des Moines, Ia.
Chandler, H., Buffalo, N.Y.
Comstock, Theo. B., Tucson, Arizona.
Conn, H. W., Middletown, Conn.
Cragin, F. W., Colorado Springs, Col.
Davis, W. M., Harvard College, Cambridge, Mass.
Dimmock, George, Canobie Lake, N.H.
Farrington, E. H., Agricultural Station, Champaign, Ill.
Ferree, Barr, New York City.
Flexner, Simon, Johns Hopkins University, Baltimore, Md.
Foshay, P. Max, Rochester, N.Y.
Gallaudet, E. M., Kendall Green, Washington, D.C.
Garman, S., Museum of Comp. Zool., Cambridge, Mass.
Golden, Katherine E., Agricultural College, Lafayette, Ind.
Hale, Edwin M., Chicago, Ill.
Hale, George S., Boston, Mass.
Hale, Horatio, Clinton, Ontario, Canada.
Hall, T. Proctor, Clark University, Worcester, Mass.
Halsted, Byron D., Rutgers College, New Brunswick, N.J.
Haworth, Erasmus, Oskaloosa, Iowa.
Hay, O. P., Irvington, Ind.
Haynes, Henry W., Boston Mass.
Hazen, H. A., Weather Bureau, Washington, D.C.
Hewitt, J. N. B., Bureau of Ethnology, Washington, D.C.
Hicks, L. E., Lincoln, Neb.
Hill, E. J., Chicago, Ill.
Hill, Geo. A., Naval Observatory, Washington, D.C.
Hitchcock, Romyn, Washington, D.C.
Holmes, E. L. Chicago, Ill.
Hotchkiss, Jed., Staunton, Va.
Howe, Jas. Lewis, Louisville, Ky.
Hubbard, Gardiner G., Washington, D.C.
Jackson, Dugald C., Madison, Wisconsin
James, Joseph F., Agricultural Dept., Washington, D.C.
Johnson, Roger B., Miami University, Oxford, O.
Kellerman, Mrs. W. A., Columbus, O.
Kellicott, D. S., State University, Columbus, O.
Kellogg, D. S., Plattsburgh, N. Y.
Lintner, J. A., Albany, N. Y.
Loeb, Morris, New York City.
Mabery, Charles F., Cleveland, Ohio.
Macloskie, G., Princeton, N.J.
McCarthy, Gerald, Agricultural Station, Raleigh, N.C.
MacDonald, Arthur, Washington, D.C.
Marshall, D. T., Metuchen, N.J.
Mason, O. T., Smithsonian Institution, Washington, D.C.
Millspaugh, Charles F., Morgantown, W. Va.
Nichols, C. F., Boston, Mass.
Nuttall, George H. F., Johns Hopkins University, Baltimore, Md.
Oliver, J. E., Cornell University, Ithaca, N.Y.
Osborn, Henry F., Columbia College, New York City.
Osborn, Herbert, Agricultural College, Ames, Iowa.
Pammel, L. H., Agricultural Station, Ames, Iowa.
Pillsbury, J. H., Smith College, Northampton, Mass.
Poteat, W. L., Wake Forest, N. C.
Preble, Jr., W. P., New York City.
Ruffner, W. H., Lexington, Va.
Sanford, Edmund C., Clark University, Worcester, Mass.
Schufeldt, R. W., Washington, D.C.
Scripture, E. W., Clark University, Worcester, Mass.
Slade, D. D., Museum Comp. Zool., Cambridge, Mass.
Smith, John B., Rutgers College, New Brunswick, N.J.
Southwick, Edmund B., New York City.
Stevens, George T., New York City.
Stevenson, S. Y., Philadelphia, Pa.
Stone, G. H., Colorado Springs, Col.
Thomas, Cyrus, Washington, D. C.
Thurston, R. H., Cornell University, Ithaca, N.Y.
Todd, J. E., Tabor, Iowa.
True, Frederick W., National Museum, Washington, D.C.
Turner, C. H., University of Cincinnati, Cincinnati, O.
Wake, C., Staniland, Chicago, Ill.
Ward, R. DeC., Harvard University, Cambridge, Mass.
Ward, Stanley M., Scranton, Pa.
Warder, Robert B., Howard University, Washington, D.C.
Welch, Wm. H., Johns Hopkins University, Baltimore, M.D.
West, Gerald M., Clark University, Worcester, Mass.
Whitman, C. O., Clark University, Worcester, Mass.
Williams, Edward H., Lehigh University, Bethlehem, Pa.